Vol. 108. Part 9. Pp. 385–407. 4 figs. 2 plates. 31st December, 1956.

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LONDON:
PUBLISHED BY THE SOCIETY AND
SOLD AT ITS ROOMS, 41, QUEEN'S GATE, S.W. 7

Price 10s. 0d.

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OBSERVATIONS ON THE MIGRATION OF INSECTS IN THE PYRENEES IN THE AUTUMN OF 1953.

By C. B. Williams; I. F. B. Common; R. A. French; Vera Muspratt and M. C. Williams.

Manuscript received 20th February, 1956.

(Read 3rd October, 1956).

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Introduction.

For many years the idea that insects—other than locusts—were capable of unidirectional flights or migrations over long distances was not accepted by the majority of naturalists. In the early part of this century, however, the accumulated evidence for such flights became so strong that it was generally admitted that some butterflies and moths regularly made flights of several hundreds of miles; but it was then held that such flights were in one direction only and were in the nature of overflows from areas of over population. Neither the migrants nor their offspring were believed to return to the original area of emigration, and so the phenomenon was very different from the to and fro migrations of birds with their regular seasonal change of direction.

This outlook was well stated by Heape in 1931, who considered that true "migration" must have a backwards and forwards flight at different seasons of the year, or in different years, as is found in birds and in fishes. "Emigration", on the other hand, was an overflow movement in one direction only, the animals taking part or their offspring eventually dying out. In this category Heape put all the insects with the single exception of the Monarch butterfly of North America, in which he admitted a movement to the north in the spring and to the south in the autumn, thus bringing it into the designation of a true migrant.

Although Heape's theories fitted not badly into the knowledge then available, as records of insect movements increased more and more species were found to have return flights and had to be moved from the "emigrant" to the "migrant" class. In some cases the flight in one direction was denser and more conspicuous than in the other, and it is curious to note in this connection that in the United

States the majority of well established migrations of Lepidoptera were to the south in the autumn, while in Europe they were to the north in the spring.

To settle these problems it has become more important than ever to seek for evidence of the southward autumn movements of insects in Europe—particularly under conditions where the observations may be repeated in different years by different observers.

Previous Observations in the Pyrenees.

Although there have been occasional records of small movements of insects southward through the Alps in the past seventy years, it was not until the Lacks' (1951) observations of large numbers of insects passing through the Port de Gavarnie in September and October 1950 that attention was focused on this part of the world. D. and E. Lack, on 13th October, saw large numbers of butterflies, dragonflies and Diptera passing through the Port, at about 7500 ft. above sea level, in a south-westerly direction from France into Spain. The butterflies included *Colias croceus* Fourc. (the commonest), *Vanessa atalanta* Linn. (next most common), and small numbers of *Pontia daplidice* Linn. One *Macroglossa stellatarum* Linn. was also seen. The dragonflies appeared to be mainly *Sympetrum striolatum* Charp. (2 captured), and the only Dipteron caught was *Syrphus balteatus* Deg. They estimated that the dragonflies were passing at the rate of several thousand an hour, and that the Diptera were at least twenty times as common as the Dragonflies.

A few days previously the Lacks had seen a somewhat similar movement to the south over the Col de Puymorens (6000 ft.), which included *C. croceus* and "Whites" (identified as *Pieris brassicae* Linn., but now thought by them to have been *P. rapae* Linn.), with smaller numbers of *V. atalanta* and *P. daplidice*.

In 1951 Gray, Locke and Putnam (1953) watched for insect migrations at the Port de Venasque (8000 ft.) at the head of one of the two valleys above Bagnères de Luchon from 8th September to 3rd October, and on every fine day they saw movements in a southerly direction, including *C. croceus*, *C. hyale* Linn. (very few), *P. rapae* (many), *P. brassicae* (very few), *P. daplidice* (rare), *Argynnis lathonia* Linn. and *V. atalanta* (also rare). The Hawk Moth *M. stellatarum* became common towards the end of September. The Diptera, especially Syrphidae, were again the most abundant migrants and there were a few dragonflies, more particularly at the beginning of October. In the same year Snow and Ross (1952) visited for short periods Gavarnie, Puymorens and Quillane and saw evidence of migration on most days, including Lepidoptera, Diptera and dragonflies.

In 1952 Mrs. V. Muspratt (1953) camped just below the Port de Gavarnie from 25th September to 5th October and saw evidence of migration on five days.

Thus observations had been taken at four different passes in the hills, mostly between 6000 and 8000 ft., in three successive years, the earliest observation being on 14th September and the latest on 13th October (but only a single day after 5th October).

It seemed worthwhile, therefore, to make a series of observations during September and October in the Pyrenees area to confirm and supplement the previous reports. The area appeared to be particularly favourable because the

physical features of the country might cause a concentration of the migrating population as it moved through the passes over the mountains or along the narrow north-south coastal plains.

The Present Observations.

The present small expedition was originally planned to try to cover the two months of September and October, but owing to financial reasons the time had to be reduced. Those taking part were :

C. B. Williams, *Head of Department of Entomology, Rothamsted Experimental Station, Harpenden*, and Mrs. E. M. Williams.

R. A. French, *Department of Entomology, Rothamsted.*

I. F. B. Common, *Commonwealth Scientific and Industrial Research Organisation, Canberra, Australia*, and Mrs. J. Common.

M. C. Williams[1], *Department of Entomology, London School of Hygiene and Tropical Medicine.*

Mrs. Vera Muspratt *of St. Jean de Luz.*

We wish to thank the New York Zoological Society for a grant towards the expenses of C. B. Williams and R. A. French ; and the University of Paris, and particularly the staff of the Laboratoire Arago at Banyuls-sur-Mer, for hospitality and for helping us in every possible way. We are indebted to Mr. R. L. Coe of the British Museum (Natural History) for identifying the Diptera.

Table I shows, in summary, the localities visited, the date, the observers, and whether or not insect migration was observed.

One point must be noted about the hours of observation. France now uses Central European time, but as the latitude of 0° (Greenwich) runs through Gavarnie all the clock times there are one hour wrong from sun-time, which is the only time of biological value. We have, therefore, altered all our times to G.M.T., which is absolutely correct for Gavarnie and only 12 minutes early for Argelès (latitude 3° E. approximately).

(1). Summary of observations according to locality.

(a) Observations on the beach between Argelès-sur-Mer and le Racou.

Just north of the point where the outspurs of the main mass of the Pyrenees reach the Mediterranean the coastline is flat and runs almost due north and south for about 50 kilometres (30 miles) from Argelès-sur-Mer northwards towards Narbonne. North of this the coast gradually turns to the north-east eventually reaching Montpellier and the north shores of the Gulf of Lyons.

As it seemed possible that this shore line might be a flight route for migrating insects, the extreme south of it between Argelès and le Racou was visited on a number of occasions from our base at Banyuls-sur-Mer. This is about 10 km. further to the south where the coast has become a series of cliffs with small bays. Plate I*a* shows a view of this coast line looking north from the hills just south of le Racou.

Behind the somewhat narrow strip of sand, which is 20 to 40 yards wide in the Argelès area, there is a low-lying grass or swampy verge with, in places, a few houses behind. At le Racou the shore turns rapidly to the east, and progress

[1] Holding a Colonial Medical Research Studentship.

TABLE I.

1953.	Argelès-s-Mer. Sea level on coast. Observers.	Migration.	Puymorens and Hospitalet. 4500–6500 ft. Observers.	Migration.	Gavarnie. 4500–8000 ft. Observers.	Migration.
September						
10	Ws.	None	.	.	.	.
14	.	.	Ws.	Very slight	.	.
15	.	.	Ws. MW. F.	None	.	.
16	.	.	Ws. MW. F.	None	.	.
17	.	.	Ws. MW. F.	None	.	.
18	.	.	Ws. MW. F.	Distinct	M.	None.
19	.	.	MW.	Distinct	M.	Distinct
20	.	.	MW.	None	M. Ws. F.	None
21	.	.	MW.	Distinct	M. Ws. F.	Slight
22	.	.	MW.	Slight	M.Ws.	Distinct
23	.	.	MW. F.	Distinct	M.Ws.	None
24	.	.	MW. F.	Distinct	M.Ws.	None
25	.	.	MW. F.	None	M.Ws.	None
26	.	.	MW. F.	None	M.Ws.	None
27	.	.	MW. F.	None	M.Ws.	None
28	.	.	MW. F.	None	M.	None
29	.	.	MW. F.	None	M.	Very slight
30	Ws.	None	.	.	M.	Distinct
October						
1	F. MW. Cs.	Definite	.	.	M.	Very slight
2	Ws. F. MW. Cs.	None	.	.	M.	Slight
3	Ws. F. MW.	None	.	.	M.	Definite
4	Ws. F. MW.	None	.	.	M.	Very slight
5	Ws. F. MW.	Definite	.	.	M.	Definite
6	Ws. F. MW.	Definite	.	.	M. Cs.	Definite
7	Ws. MW.	None	.	.	M. Cs.	Definite
8	Ws. MW.	Slight	.	.	Cs. F.	Definite
9	Ws. MW.	Very slight	.	.	Cs. F.	Definite
10	MW.	None	.	.	F.	Good
11	.	.	.	.	F.	None
12	.	.	Ws.	None	F. MW.	None
13	.	.	Ws.	Very slight	F. MW.	None
14	.	.	Ws.	None	F. MW.	None
15	.	.	.	.	F. MW.	None

Ws = C. B. and Mrs. E. M. Williams. M = V. Muspratt. Cs = I. F. B. and Mrs. J. Common. MW = M. C. Williams. F = R. A. French.

directly to the south is blocked by rapidly rising land with some small cliffs, which eventually lead to hills, such as Tour de la Massane, which are about 2500 to 3000 ft. high. Valleys run into this block of hills from the north and from the sea (fig. 1).

10th September, 1953[2]**:** A warm day but with a very strong north wind blowing down the beach. Many migrant species were present, such as *P. rapae*, *P. daplidice* and *C. croceus* and one *M. stellatarum* was seen, but all insects were definitely troubled by the wind and were usually sheltering on the lee side of bushes, or close to the ground in hollows.

[2] The persons responsible for the observations each day can be found in Table I.

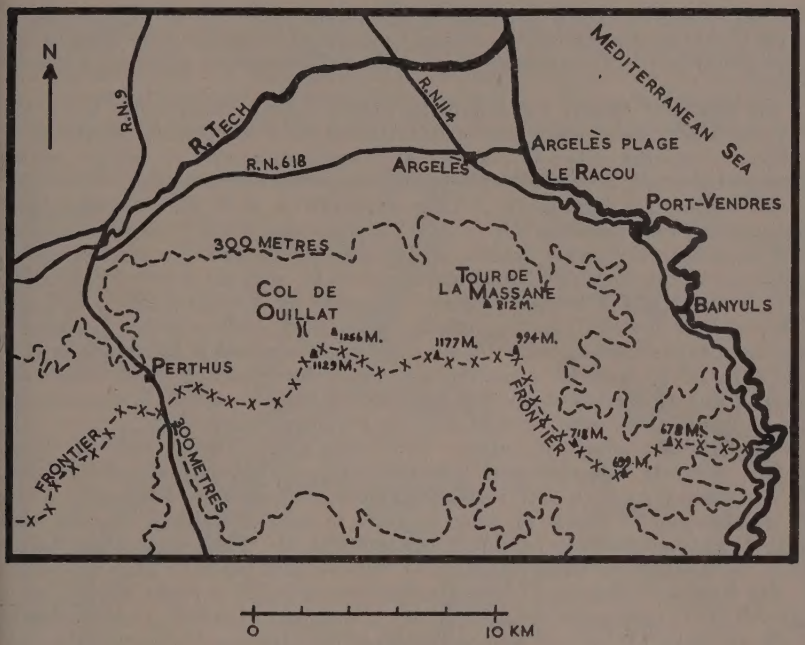

FIG. 1.—Map of the Argelès-Banyuls district.

30th September : No other visit was paid until the afternoon of 30th September. The morning had been sunny with a strong north wind, but cloud spread in the afternoon and the wind became lighter but gusty. Temperature 72° F. at 14.15 G.M.T. Between 14.30 and 15.15 most of the commoner migrants were seen, including *P. daplidice* (common), *P. rapae* (less common), *C. croceus* (a few) and one *M. stellatarum*, but there was no sign of directional movement. By 15.15 the haze was thick enough to obscure the sun.

1st October : Argelès was visited from 12.15. Wind light N.E., the sky nearly clear, and temperature just below 70° F. Considerable numbers of butterflies were flying to the south at 12.15 and continued till 16.15, when they were very few, and at 16.30 none. Observations were taken at three points simultaneously; one on the soft sand from the sea to about 40 yards inland, and two on the short herbage between this and the houses, a distance of about 80 yards. Two counts of half an hour each were made from 12.40 to 13.10 and from 15 to 15.30 approximately. The main migrants in the early count were white butterflies : *P. rapae* and *P. daplidice*, of which 118 went to south and only 16 to north ; *C. croceus* 10 to south ; Swallowtails (*Papilio machaon* Linn.) 8 to south and 1 to north ; together with 3 *V. atalanta*, 3 Fritillaries and 3 *M. stellatarum*, all to south. During the afternoon count only three *C. croceus* were seen, all going south ; and " Whites " were moving in smaller numbers and in less definite direction —96 to the south and 36 to the north in the half hour.

This was the most definite migration seen at Argelès.

2nd October : Morning cloudy with slight rain and the wind irregular from

the sea. Temperature 67° F. at 12.30. There was no directional movement, but in the afternoon the weather cleared and a number of butterflies were flying round. Captures included *Plusia gamma* Linn., 1 *M. stellatarum* and 1 *Lampides boeticus* Linn.

3rd October : Cloudy but improving slightly later. Wind N.E. For a few minutes before noon there was some evidence of a southward movement of " Whites " and one or two *C. croceus*. In the afternoon, with the sun just visible through the cloud, *P. daplidice* were flying round but not migrating

5th October : A warmer day. Temperature 75° F. at 10.45, but with a fairly strong gusty wind from the N.W. By 11.30 there was a fairly steady movement of *P. daplidice* and *P. rapae* to the south (15 in 10 minutes) and the thin movement continued all the morning. In 15 minutes at 13.10, with the temperature 78° F., 19 " Whites " and 2 *C. croceus* passed to south on a 40-yard front, and five " Whites " to north. The movement continued till 15.00. A few " Whites " were seen flying over the sea. On the bend of the shore at le Racou the butterflies appeared to leave the shore line and to continue their journey towards the south, rising up the low steep cliffs and passing inland. A few *V. atalanta* and one *V. cardui* Linn. were seen, all going in a southerly direction.

6th October : Clear sky, sunny, very little wind. Temperature 73° F. at 12.30. A steady, thin movement was observed from 11.30, including *P. daplidice*, *P. rapae* and *C. croceus*, with smaller numbers of *V. atalanta*, *L. boeticus*, a few *P. machaon* and *V. cardui*, all going to south in spite of a change of wind from light E. at about 11.00 to light N.W. at about 14.00. Three *Gonepteryx rhamni* Linn. were seen going south ; this species was not seen before or after this day.

7th October : Sky almost clear, temperature at midday about 75° F., but a gusty N.N.W. wind much stronger than previous day. Between 11.45 and 14.15 there was little evidence of any activity, and no evidence of directional movement—not a quarter as many butterflies as a week ago.

8th October : Clear, bright, still day. Temperature just under 70° F. Comparatively little activity among the butterflies—one *V. atalanta* was seen flying out to sea to the S.E. A small movement of dragonflies (mostly paired) was observed at about midday, for about 10 to 15 minutes, all going to the north.

9th October : Clear sky, haze, almost dead calm. Temperature 67° F. at 13.00, wind slightly freshening. Very slight evidence of movement to the south —*P. daplidice*, a few *V. atalanta*, one or two *C. croceus* and one *V. cardui*. No dragonflies seen.

10th October : After midday, temperature about 68° F., cloudy, wind light N.W., there was a slight movement to the south. Between 13.00 and 13.30 16 " Whites " (mostly *P. daplidice*, fewer *P. rapae*), three *C. croceus* and a Fritillary were seen flying to the south ; after this no evidence of movement. On this day two *P. brassicae* (1 ♀ and 1 ♂) and one *P. napi* Linn. were captured, the only ones definitely seen at Argelès.

Thus at Argelès observations were taken on eleven days and on five of these there was evidence of a southward movement of butterflies, but no evidence of similar movements of dragonflies (except perhaps on one day to the north) or of Diptera.

(b) Observations at Puymorens.

About 70 miles west from the Mediterranean the valley of the Ariège River runs south from Foix, turns south-east from Tarascon to Ax-les-Thermes and then almost due south to Hospitalet at 4500 ft. Here the valley divides, one branch

rising rapidly to the south-west towards Andorra, with the Port d'Embalira at 8000 ft. The second branch rises rapidly to the south-east to the Col de Puymorens (6530 ft.), falls again to Porté, and then runs on to the south or south-east to the frontier at Bourg Madame (3500 ft.). We made our headquarters at the hotel on the Col de Puymorens which has the advantage over most other

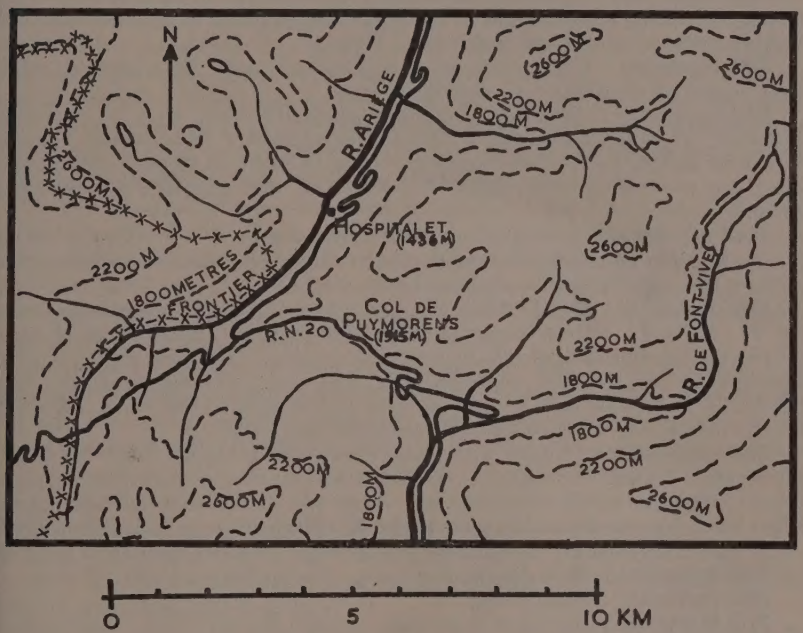

FIG. 2.—Map of the Hospitalet-Col de Puymorens district.

passes in that both sides are in French territory. Fig. 2 shows a map of the immediate neighbourhood of the Puymorens pass and Hospitalet, and Plate I*b* shows a view looking from the slopes near the Col northwards down the Ariège valley. The peaks in the immediate neighbourhood reach 8000 to 9000 ft.

14th September : A fine sunny day with occasional cloud, wind light S.E., rain and clouds in evening. *P. rapae* and *C. croceus* were moving to the S.W. from 08.30–11.30 and 13.20–15.50, most pronounced in the afternoon but never more than one insect per five minutes.

15th September : Cloudy with rain at first, wind slight N.W., only very occasional sun. No insect activity observed.

16th September : Mixed sun and clouds, wind light E., gusty. Only a few butterflies seen, with no directional movement.

17th September : A fair day but with high cloud and no sun till late afternoon, wind light W. About 10 Lepidoptera were seen ; no directional movement.

18th September : A fine day, some cloud in morning, sunny all afternoon, thunderstorm at night. Wind moderate S.E., becoming light S.W. in afternoon. Temperature 65° F. at 12.20. *C. croceus*, *P. rapae* and *P. brassicae* were observed

moving in a southerly direction from 12.00 to 15.00. Between 13.40 and 14.30 numbers reached about one within sight every two minutes. Occasional *V. atalanta*, *V. cardui*, *M. stellatarum* and dragonflies were also moving south. In the morning numbers of *Eristalis tenax* Linn. (Diptera: Syrphidae) had been seen feeding on flowers, and from 13.40 to 15.20 were moving to the south, about two to four ft. from the ground, up to about one per minute on a five-yard front.

19th September : Morning cloudy and misty, some sun in early afternoon but clouded again by 14.00. From 11.00 to 15.00 only 18 butterflies were seen, all moving to the south ; 12 of these were " Whites."

20th September : Cloudy with only occasional sun, wind W. moderate. Only four butterflies were seen ; no directional trend.

21st September : Fine day with many sunny intervals, wind W., becoming N. later. From 09.25 to 15.25 a southerly movement of *P. brassicae*, *P. rapae*, *C. croceus* and *L. boeticus* was observed ; from 13.00 to 13.40 they were passing about one per minute within sight. Some *Eristalis* were moving S.S.W. at about 13.00.

22nd September : Cold day, maximum temperature 51° F. Mostly cloudy but some sun in afternoon, wind moderate N. Only 12 butterflies were seen, but of these five were *C. croceus*, all going to the south.

23rd September : Cloudy with many sunny intervals. Temperature at noon 60° F. Butterfly activity observed from 10.00 to 13.30 ; small numbers of *C. croceus* moving to south, about one every 15 minutes. Very few *Pieris*, but one *Pontia daplidice* (the first recorded here) was seen. *M. stellatarum* and very occasional *V. atalanta* and *A. lathonia* were also moving to the south. *Eristalis tenax* were moving to the south between 12.30 and 14.30.

24th September : Sunny with thin cloud. Wind light N.E. Maximum temperature 60° F. *P. rapae*, *P. daplidice* and *C. croceus* were moving south from 10.00 to about 15.30—about one every two minutes in sight during the afternoon. Very occasional *V. atalanta* and *M. stellatarum* were also moving south. A very thin movement of *Eristalis* sp. to south was observed from 13.55 to 14.40.

25th September : First drizzle, then rain. No butterfly activity.

26th September : Rain all day.

27th September : Light sun in morning, clouded over by 12.00. Temperature 57° F. at 11.30. Of 15 Lepidoptera seen, 13 were flying in a southerly direction, including *P. rapae*, *P. daplidice*, *P. brassicae*, *V. atalanta* and *M. stellatarum*.

28th and 29th September : Cold and misty with snow at higher levels. No insect activity observed.

From this date no observations were taken until 12th October, when for three days a watch was kept in the valley just above Hospitalet (about 4500 ft.).

12th October : Cloudy nearly all day. A few butterflies seen. In sunny intervals a few *C. croceus*, dragonflies and Syrphidae were seen flying up the valley to the south.

13th October : Rain all night and morning, but cleared about 11.30. From 12.45–14.30 a thin but steady movement of " Whites " (almost all *P. rapae*) was observed flying up the centre of the valley chiefly near or over the stream, and mostly about 20 ft. up. 16 were seen in thirty minutes, then the heavy clouds returned and no further activity was noted.

14th October : Steady rain nearly all day. No sign of any activity.

Thus at Puymorens observations were taken on 16 days between 14th and 29th September, and evidence of southerly migration of Lepidoptera was obtained on seven of these. On most of the others the weather was too cold or wet. A few Syrphidae were also migrating, but dragonflies were only seen on one day. At Hospitalet observations were taken on 12th, 13th and 14th October in cold,

rainy weather. A southerly movement of white butterflies was seen in the only sunny intervals.

(c) Observations at Gavarnie.

The village of Gavarnie, 4488 ft. above sea level, lies almost on the Greenwich meridian about 95 miles from the Atlantic coast and 160 miles from the Mediterranean. It is situated near the head of the valley of the river Gave de Pau, which runs almost due south for 20 miles from Lourdes. This valley terminates abruptly about three miles above Gavarnie village in a semi-circular precipice, the Cirque de Gavarnie, rising 3–4000 ft. above the valley floor. About one and a quarter miles north of the Cirque another valley goes off through a steep, rather narrow, entrance; this is the Pouey Aspé valley which leads directly W.S.W., up to the Port de Gavarnie (7388 ft.).

Most of the observations were made in or near to the Pouey Aspé valley or at the Port itself. The Port, which lies on the Franco-Spanish border, is a narrow saddle-shaped pass about twenty yards wide, looking eastwards down the Pouey Aspé into France and westwards down a similar but steeper valley into Spain. All the insects which ascended the Pouey Aspé valley and went through the Port were taking a W.S.W. direction.

In the Pouey Aspé valley one of the observers, Mrs. V. M. Muspratt, was camping at a height of approximately 6000 ft. (Position 1 on the map, fig. 3), and here some of the records were taken. Other observations were made at the Col de Tantes, 7344 ft. (Position 2), which lies on the northern ridge of the Pouey Aspé valley between it and the next valley, the Valleé des Espécières, which also eventually leads down to Gavarnie. Further observations were made on the Plateau Bellevue, about 5600 ft. (Position 3); and on the floor of the main Gavarnie valley (Position 4), near the entrance to the Pouey Aspé valley.

Plate II*a*, shows the Pouey Aspé valley from the Port de Gavarnie looking down to approximately E.N.E.

Plate II*b*, shows the upper Pouey Aspé valley with the Port de Gavarnie in the background, towards the left of the centre, and the Col de Tantes towards the right.

18th September : Grey, with some rain. No signs of migration.

19th September : Good weather. By 09.30 4 *P. rapae* and 5 *C. croceus* were seen moving W.S.W., near the camp (Position 1). At the Port de Gavarnie during one hour 10 *C. croceus*, 7 *P. rapae*, 1 *L. boeticus* and 2 large blue dragonflies were seen going W.S.W. At about 14.00 1 *C. croceus* and 1 *P. rapae* were seen.

20th September : A grey cloudy day with occasional rain or drizzle. Temperature 56° F. at 11.00 at 6250 ft. The afternoon was a little warmer and the sun appeared about 14.00. A few *P. rapae* and *C. croceus* were seen but there was no sign of migration in any part of the Pouey Aspé valley all day.

21st September : A clear sky, bright sun in morning with high cirrus cloud spreading. No wind except at the Port, where it was cold and westerly. Temperature 68° F. at noon on Plateau Bellevue. Cloud spread rapidly from the south in the afternoon. By 13.00 the wind dropped, then veered to N. to bring mist up the valley.

Thirty minutes (about 11.00) at the Port produced 2 *V. atalanta*, 1 large dragonfly, about 30 Syrphids and a few bluebottles, all unsuccessfully trying to cross against the wind. At a position (4) above Gavarnie, at the mouth of the

GAVARNIE
1370M
1600M
FOOTPATH
4
GAVE DE PAU
1800 METRES
PLATEAU DE LA VUE
3
CIRQUE DE GAVARNIE
VALLÉE DES ESPÉCIÈRES
VALLÉE DE POUEY ASPÉ
1
2000 METRES
2200 METRES
2400 METRES
2600 METRES
PIC DE LA HULE
2291M
PIC DE TANTES
2323M
5
FOOTPATH
COL DE TANTES
2210M
PIC ENTRE LES PORTS
2480M
LAC DE LUHOSO
2215M
PIC DE ST. ANDRÉ
2603M
FRONTIER
PIC DE LARY
2389M
PORT DE GAVARNIE
2252M
GABIETOU
3031M
TAILLON
3143M
7
BRÈCHE DE ROLAND
3001M
CASQUE
3205M
TOUR DU MARBORÉ
3012M
MARBORÉ
3250M
FRONTIER
PIC ROUGE DE PALLA
2777M
HOURQUETTE D'ALLANS
2437M
PIC DE BASTAZOU
3014M
6
FOOTPATH
2800M
3000M
3400M
N
1 KM.
0
500M
1000M

Pouey Aspé valley, there was little activity before 10.10, when a S.W. movement of butterflies was seen. At the same time numbers of a small beetle, *Aphodius contaminatus* Herbst, were going S.W. across the valley. Between 10.10 and 10.30, 8 *C. croceus*, 8 *P. rapae*, 3 *L. boeticus*, 2 dragonflies and 1 *V. atalanta* went S.W. to W.S.W. up towards the Port. From 10.35 to 11.00, 12 " Whites," 4 *C. croceus*, 1 " Blue " and 4 *L. lathonia* were seen, while in a further half hour, 11.15 to 11.45, butterflies were passing on a 50-ft. front at 1 per minute, all going S.W. From 11.50 to 12.15 only 1 *L. boeticus* and 1 *M. stellatarum* were seen ; while between 12.30 and 13.15 6 " Whites " were flying S.W. " Whites " then became more active, 45 were seen between 13.15 and 13.30, and 46 in the next 15 minutes, all flying 20–50 ft. up and moving S.W. ; 3 *C. croceus* were also seen, 2 going S.W. and 1 S.E. Observations were also made on the eastern slope of the Gavarnie valley (Position 6) between 08.45 and 11.00 ; 12 *P. rapae*, 2 *C. croceus* and 1 *A. lathonia* were seen flying W.S.W. down the hillside and across the main valley.

22nd September : Bright sunny day with a few clouds moving N.E. Wind slight S.W. to N.W. Temperature 54° F. at 14.00 at 6000 ft. Butterflies were active at the camp by 09.30. Between 09.30 and 10.15, 53 *C. croceus*, 4 *L. boeticus*, 19 *P. rapae*, 1 *P. daplidice* and 2 other butterflies were seen going W.S.W. up towards the Port. From 11.15 to 11.30 a count on a 30-yard front gave 15 *C. croceus* and 16 *P. rapae*. By the afternoon both these species had ceased migrating, although one *L. boeticus* and one *P. machaon* were seen flying up the valley.

On the way up from Gavarnie to the Plateau Bellevue 2 *C. croceus* and 1 Fritillary were moving by 08.30 ; while on the Plateau itself 5 *Aphodius* were caught flying N.W. and 4 *C. croceus*, 2 " Whites," 1 *V. atalanta* and 1 Syrphid were seen flying to the S.W. between 09.10 and 10.15. In the following 45 minutes 6 *C. croceus*, 3 " Whites " and 1 *L. boeticus* were seen flying W.S.W., while in the next 15 minutes these numbers increased to 12 *C. croceus*, 12 " Whites," 1 *L. boeticus*, 1 *M. stellatarum* and 2 Syrphids. A count between 12.00 and 12.15 produced 9 *C. croceus*, 15 " Whites," several Syrphids, 3 *L. boeticus*, 1 *M. stellatarum* and 1 dragonfly, all flying W.S.W. Between 13.20 and 13.35 the numbers had increased to 20 *C. croceus*, 19 " Whites," 4 *L. boeticus*, 2 *V. atalanta*, 4 " Browns ", 2 Syrphids and 1 dragonfly. The flight of " Whites " and " Yellows " still continued at 14.40 and 1 *V. atalanta* was seen going S.W. at 15.10.

23rd September : Strong cold W. wind, black clouds moving N.E. Temperature 53° F. at 13.00. Thunder and rain at 15.30. No migration.

24th September : Heavy rain during the night, snow on mountain tops. Cold, cloudy, rainy day. No migration.

25th September : Cold, cloudy, rain and mist. No migration.

26th September : Very heavy rain during the night. Cold, rain all day. No migration.

27th : Thunderstorm during the night. Cold, cloudy, rain, snow down to 7400 ft. No migration.

28th September : Cold, rain. No migration.

29th September : Freezing night. Lovely day, cold E. wind, snow on peaks. 1 *C. croceus* seen at 10.00 at 6900 ft. and 3 *P. rapae* at 7000 ft. in the afternoon, all flying W.S.W. from Pic de Tantes to Col de Tantes. Two *E. tenax*, 1 *C. croceus* and 1 *P. rapae* caught.

30th September: Cold night. Lovely day, cool wind, warm sun. *C. croceus* seen near camp at 09.30. From this time to 13.30, 25 *C. croceus*, 1 *L. boeticus*, 1 *A. lathonia*, 1 *P. rapae* and 1 *Polyommatus icarus* Rott. were seen going W.S.W. The last three and several *C. croceus* were captured.

1st October : Fine cool day, clouds descended at about 13.00. Two *C.*

croceus seen going S.W. on the Brèche de Roland glacier (Position 7) at 8700 ft., 1 *V. atalanta* seen going through the Brèche, at 8900 ft., and 3 *Aglais urticae* Linn. seen in the same area, but not migrating. One Syrphid found torpid on the glacier.

2nd October : Overcast with cold E. wind. At 09.30 *C. croceus* were flying but not migrating. By 11.00 a count for 30 minutes showed 20 *C. croceus* going W.S.W.; 5 were captured.

3rd October : Overcast, high clouds, sun at times. At 09.30, about half a mile below the camp, *C. croceus* was seen flying and on the grass; later just above the camp this species and *V. atalanta* were migrating W.S.W. A count from 11.15 to 11.50 gave 71 *C. croceus*, 31 *V. atalanta*, 3 *M. stellatarum*, 2 *V. cardui* and 3 *A. urticae*, all going W.S.W. By 12.15 *C. croceus* had decreased in intensity but not *V. atalanta*. 24 *C. croceus*, 1 *V. atalanta* and 1 *P. rapae* were caught.

4th October : Cold W. wind, drizzle later. Near the Col de Tantes *C. croceus* were found asleep in the grass but later 7 were seen flying W.

5th October : Fine day. Both *C. croceus* and *P. rapae* were on the move at 09.15 just above Gavarnie and on the Plateau Bellevue going W.S.W. in about equal numbers. Above the plateau and near the camp *C. croceus* was more common than *P. rapae* and still migrating W.S.W. *V. atalanta* and *A. urticae* were still flying at 16.45 but not migrating. 14 *C. croceus* and 3 *P. rapae* were caught.

6th October : Beautiful weather, cloudless sky after early mist. No wind. The first butterflies were seen at 08.50. A count of 15 minutes on a 30-metre front gave 24 *C. croceus* and 3 *P. rapae* near the camp. Later 2 *L. boeticus* were seen. At the Port de Gavarnie *C. croceus* was going W.S.W., but *A. urticae* was going S. at a rate of 27 in 15 minutes. 16 *C. croceus*, 5 *A. urticae* and 1 *P. rapae* were captured. In the Gavarnie valley *P. rapae*, *C. croceus* and *M. stellatarum* were seen at 09.30, but not migrating. Four counts were made during the day on or near the Plateau Bellevue, the first three of 30 minutes and the fourth of 15 minutes duration, all on a 45-yd. front.

	11.27–11.57.	12.00–12.30.*	12.00–12.30.*	13.10–13.25.
C. croceus .	12	13	21	9
P. rapae .	3	7	5	1
G. rhamni .	1	.	.	.
A. lathonia .	.	.	4	.
L. boeticus .	.	.	2	.
V. cardui .	.	.	.	2

* Counts made by two people at the same time.

The direction of movement was always S.W. 7 *C. croceus*, 5 *P. rapae* and 1 *A. lathonia* were captured.

7th October : Beautiful weather, cloudless sky after morning mist. Near the camp 2 *A. urticae*, 1 *P. rapae*, 11 *C. croceus* and 1 Syrphid were caught. Shortly before 12.00 " Whites," " Yellows " and *M. stellatarum* were seen flying up to the Port. At the Port a light E.N.E. wind was blowing and the butterflies there showed no evidence of migrating. In the afternoon butterflies and other insects were seen flying W.S.W. near the Col de Tantes, including *C. croceus*, *P. rapae*, *Polygonia c-album* Linn. and *V. atalanta*. Also two species of Calypterate flies and one *P. gamma* were caught. Two counts of one minute on a 2-yd. front yielded 8 and 9 flies respectively. 1 *P. c-album*, 2 *L. boeticus* and 2 *C. croceus* were caught.

8th October : Clear sky, very slight cool E. wind. Temperature about 50° F. from 11.00 to 15.00. Observations were made at the Col de Tantes and on a small plateau just above and to the N.E. of the camp site (Position 5).

(i) *Col de Tantes :* Little movement seen before 12.00, when both Lepidoptera and Diptera were moving S.W.; 2 species of Syrphidae, 3 species of Calypterate flies, 3 species of Ichneumons, *A. lathonia*, *L. boeticus*, *V. atalanta*, *C. croceus*, *A. urticae*, *P. c-album*, *P. rapae* and *M. stellatarum* were recorded. By 14.00 the numbers had increased and the following counts were made of butterflies flying S.W. :

	14.05–14.35.	14.35–14.50.	14.50–15.05.	
C. croceus . .	19	23	19	During the second count 3 *C. croceus* were seen going N.E. and 2 more during the third count.
A. lathonia . .	2	.	.	
P. rapae . .	3	1	2	
A. urticae . .	1	.	.	
L. boeticus . .	2	2	1	
V. atalanta . .	3	2	1	
M. stellatarum .	1	.	.	

The numbers of Lepidoptera reached a peak at about 14.30, but the Diptera had decreased since the morning. The migration was still in progress here at 15.15 although it had ceased in the lower Pouey Aspé valley.

Lepidoptera caught : 1 *C. croceus*, 1 *P. rapae*, 5 *L. boeticus* and 2 *A. lathonia*.

Diptera caught : 11 *Eristalis tenax*, 13 *Cryptolucilia caesarion* Meig., 31 *Calliphora erythrocephala* Meig., 2 *Calliphora vomitoria* Linn., 1 *Dasyphora salticum* Lond. and 3 Hymenoptera.

(ii) *Position 5 :* Small scarabeid beetles, *Aphodius contaminatus*, were seen flying S.W. at the rate of 9 per 5 minutes on a 1-ft. front and 3 ft. above the ground. All Lepidoptera seen or caught in this locality were moving W.S.W. unless otherwise stated. From 11.00 to 12.00 14 *C. croceus* (3 captured), 9 *P. rapae* (1 captured), 1 *L. boeticus* and 1 Syrphid were seen on a 50-yd. front. Most insects, except *P. rapae*, tended to fly below head height. Between 13.00 and 14.00 14 *C. croceus* (4 captured), 6 *P. rapae* (2 captured), 1 *V. cardui*, 1 *P. daplidice*, 1 *A. lathonia* (captured) and 1 *L. boeticus* (captured) were seen. From 14.15 to 14.45 the position was moved approximately 100 yds. E. to the head of a small defile leading to the plateau. The direction of the defile gave the migrants a westerly orientation. 17 *C. croceus* (2 captured), 7 *P. rapae* (3 captured), 3 *A. lathonia* (2 captured) were seen. During the day Syrphids and other Diptera were passing but it was nearly impossible to catch them in this locality and difficult to count them as well as the Lepidoptera.

9th October : Bright sun, no cloud, wind slight E. to E.S.E., cool. Maximum temperature at Port de Gavarnie 55° F. at 14.00.

(i) *Port de Gavarnie :* From 11.00 to 12.00 6 *C. croceus* (2 captured), 2 *P. rapae* (1 captured), 1 *A. lathonia* (captured), 1 Blue (captured), 2 dragonflies and numerous Diptera (5 *E. tenax* and 1 *C. caesarion* captured) were flying W. through the Port. At the same time 34 *A. urticae* were migrating to the south across the path of the other migrants ; they descended from the Pic entre les Ports, across the Port and ascended the opposite slope in the direction of Taillon. A separate count of the Diptera only was made on a 10-yd. front ; 70 were recorded in 5 minutes from ground level up to 2 ft. The size and apparently rapid flight of the Diptera makes their capture difficult unless a site is selected where they are outlined against the sky or light rocks. Such a position was found a few yards north of the Port itself. From 13.00 to 13.30 23 *E. tenax*, 1 *S. balteatus*, 1 *Scaeva pyrastri* Linn., 14 *C. caesarion* and 3 *C. vomitoria* were captured on a 4-yd. front and a 5-minute count on the same front gave 189 insects all flying to the west.

(ii) *Col de Tantes:* The following counts of the Lepidoptera migrating S.W. were made:

	11.32–11.47.	12.32–12.47.	13.32–13.47.	14.00–15.00.	14.32–14.47.	14.50–15.05.
C. croceus	7	6	.	16	17	17
A. lathonia	1	2	1	5	3	3
P. rapae	4	1	.	3	2	2
L. boeticus	2	.	.	6	4	7
A. urticae	1	2	.	1	.	1
V. cardui (?)	.	1	.	.	.	.
V. atalanta	.	3	3	15	9	10
P. daplidice	.	.	.	4	.	.
Dragonflies	.	1	.	.	.	.

The following counts were made of Diptera on an 8-ft. front for periods of 3 minutes each:

	11.00. a.	11.00. b.	12.00.	13.00.
Large Calypterates	.	1	5	7
Small Calypterates	.	.	5	5
Syrphids	3	.	7	7
Others	1	1	1	6

To obtain a more accurate check on the species of Diptera migrating, four one-hour catches were made.

	Syrphidae.	Calypterates. Large.	Calypterates. Small.	Hymenoptera.	Others.	Total.
11.00–12.00	12	5	9	1	2	29
12.00–13.00	26	4	6	5	4	45
13.00–14.00	19	11	14	1	1	46
14.00–15.00	11	9	18	.	.	38

These insects were identified as follows:

E. tenax 60, *S. balteatus* 7, *S. pyrastri* 1, *C. caesarion* 46, *C. erythrocephala* 22, *C. vomitoria* 6, *Dasyphora pratoria* Meig. 1, *Polietis lardaria* Fab. 3, *Helina* sp. 2, *Sarcophaga subvicina* Rohd. 1, *Sarcophaga* sp. 1.

There was some slight variation in flight direction between S. and S.W. Most of the Diptera flew within two feet of the ground, although occasionally they were head high, whereas the Lepidoptera flew below waist height, except *P. rapae* and *V. atalanta* which often flew above head height. The Hymenoptera may have been more numerous than the number suggests as their habit of flying very low made them particularly difficult to see.

10th October : Sky with only faint traces of cirrus away to south, wind slight, cool, westerly. Maximum temperature recorded, 52° F. at 13.30 at the Port de Gavarnie. For the first time for some days there had been no frost in the Gavarnie valley. The wind became stronger and colder later, tending to blow the insects back. Diptera were recorded and captured at the Port de Gavarnie in the same location as on the previous day. Three periods of 30 minutes were spent catching and three periods counting, the locality was the same in each period and the direction of flight to the W.

Captures of Diptera (on 4-yd. front).

	11.10–11.40.	12.15–12.45.	12.55–13.25.
E. tenax . .	1	6	3
S. balteatus . .	1	2	9
S. vitripennis .	.	.	1
S. corollae . .	.	.	1
S. pyrastri . .	2	.	.
D. fasciata . .	1	.	.
C erythrocephala .	5	2	8
C. vomitoria . .	1	4	2
C. caesarion . .	1	.	4

Counts of Diptera (on 4-yd. front).

11.41–11.46, 75; 12.46–12.49, 340; 13.27–13.32, 102.

It is obvious from the above that the numbers of these insects caught is not a reliable estimate of the numbers passing.

During this same period about 12 *C. croceus* and 6 *V. atalanta* went through the Port: this passage was only accomplished if they flew close to the ground, the strong wind tending to blow the high flyers back. This was also the case with those Diptera which swerved upwards to avoid capture.

By 14.00 activity had ceased at the Col de Tantes and the weather showed signs of deteriorating.

11th October: Cool, wind slight, variable, S.S.W. to W. Mist gradually descended to valley producing fine rain continuing on and off all day. Maximum temperature 55° F. No migration.

12th October: Mist and rain all day. Maximum temperature 55° F. No migration.

13th October: Mist and rain at first, clearing later in morning. Rain in the afternoon. Maximum temperature 51° F. No migration.

14th October: Rain all day. No migration.

15th October: Rain up to time of departure at midday. No migration.

Observations were made in the Gavarnie district continuously from 18th September to 15th October. Out of these 28 days evidence of migration was seen on fourteen, and again nearly all the blank days were cold, wet and sunless. On the good days the movements were very extensive and included Lepidoptera, very large numbers of Diptera, a smaller number of Hymenoptera, but very few dragonflies. One of the best days was 10th October, which was the last fine day for observation, so that there is no evidence that we had seen the end of the migration.

(2) Summary of observations according to species.

Lepidoptera.

"*White Butterflies*".—The species included are *Pontia daplidice*, *Pieris rapae* and *Pieris brassicae*, the latter being only occasionally seen and probably distinguished on most occasions. It was at times difficult to distinguish between *P. daplidice* and *P. rapae* at a distance and it was usually these two species which were recorded on such occasions as "Whites". However, when possible to identify accurately *P. daplidice* and *P. rapae* were recorded separately.

P. brassicae: First seen on 18th September at Puymorens, and on the 19th and again on the 21st it was taking part in small numbers in the southerly migra-

tion. Only very few were seen and none captured in the migrations at Gavarnie.

P. rapae : Seen regularly from the first to the last days of observation : thin movements at Puymorens every fine day from 14th–27th September, and at Hospitalet (below Puymorens) on 13th October. One of the commonest migrants at Gavarnie from 19–30th September.

P. daplidice : Seen at Argelès on 10th September and moving to the south there from 1st–10th October. Migrating at Puymorens in small numbers from 19th–24th September. Migrating regularly at Gavarnie on all fine days during the period of observations.

C. croceus : Flights observed in a southerly direction in all three localities from 14th September to 12th October. At Gavarnie on 22nd September a count gave 80 per hour within sight and on 9th October 68 per hour.

L. boeticus : Migrating in small but steady numbers at Puymorens and at Gavarnie in a southerly direction over most of the period of observation. It was common, but with no definite movement, at Argelès.

V. atalanta : Movements in a general southerly direction, but in small numbers, were seen in all three localities from 18th September to 9th October. On 3rd October at Gavarnie they were passing at the rate of about one per minute within sight at about noon.

A. urticae : Quite a definite movement was seen in early October in the Gavarnie area ; on one occasion in a more definite southerly direction than the other species (which were moving to the south-west) and across their line of flight.

P. machaon : Out of about 18 individuals seen all except five were flying to the south or south-east. Most were seen on the coast at Argelès between 19th September and 9th October.

A. lathonia : Between 30th September and 12th October about thirty were observed in the Gavarnie area, nearly all flying to the S.W. It was present at Argelès and possibly migrating. The only one seen at Puymorens was also moving to the south.

V. cardui : Of 17 seen at all three localities, all but two were moving to the S. or S.W.

G. rhamni : Three seen at Argelès and one at Gavarnie, all flying to S. or S.E.

M. stellatarum : Between 16th September and 8th October about 45 were seen. Those at Puymorens and Gavarnie were nearly all moving to the S. or S.W. The direction was less definite at Argelès on the coast.

P. gamma : Small numbers were seen but no particular evidence of migration was observed during daytime hours.

Odonata.

Dragonflies were seen only in small numbers at all three localities. Those in the hill stations were more often moving to the S. or S.W. : but at Argelès the movement, if any, was to the N. There was definitely no large southerly migration of dragonflies in the autumn of 1953.

Diptera.

Owing to the difficulty of identifying the Diptera when in flight accurate information about the species can only be obtained from captured specimens. We brought back about 350 Diptera and the following table shows the species, and numbers of each sex. Nearly all were captured at Gavarnie in the four days from 7th–10th October, when weather conditions were very good. More detailed descriptions of the flight will be found under these dates in the section

describing observations at Gavarnie. There is no doubt of the existence of a regular southward autumn migration in immense numbers for at least half a dozen species.

Total Diptera Captured.

(*P* = Puymorens. *G* = Gavarnie).

	Male.	Female.	Total.		Dates.
SYRPHIDAE					
Eristalis tenax Linn.	21	97	118	*G.*	Sept. 22; Oct. 7, 8, 9, 10
				P.	Sept. 12, 18, 19, 22, 23, 24
Syrphus balteatus Degeer	2	18	20	*G.*	Oct. 9, 10
S. vitripennis Meig.	.	1	1	*G.*	Oct. 10
S. corollae Fab.	1	.	1	*G.*	Oct. 10
Scaeva pyrastri Linn.	1	3	4	*G.*	Oct. 9, 10
Helophilus trivittatus Fab.	1	.	1	*G.*	Oct. 7
Didea fasciata Macq.	1	.	1	*G.*	Oct. 10
CALLIPHORIDAE					
Cryptolucilia caesarion Meig.	44	38	82	*G*	Oct. 7, 8, 9, 10
Calliphora erythrocephala Meig.	20	56	76	*G*	Sept. 22; Oct. 7, 8, 9, 10
C. vomitoria Linn.	4	14	18	*G.*	Oct. 8, 9, 10
MUSCIDAE					
Sarcophaga subvicina Rohd.	1	.	1	*G.*	Oct. 9
Sarcophaga sp.	.	1	1	*G.*	Oct. 9
Dasyphora pratoria Meig.	1	.	1	*G.*	Oct. 9
D. salticum Lond.	.	1	1	*G.*	Oct. 8
Helina sp.	.	2	2	*G.*	Oct. 9
Polietes lardaria Fab.	.	4	4	*G.*	Sept. 22; Oct. 9

Coleoptera.

Slow movements of the small beetle *Aphodius contaminatus* Herbst were recorded independently by two observers in the Gavarnie area—on 21st and 22nd September in the Gavarnie valley at about 4600 ft., by C. B. W. and E. M. W., and on 8th October on the Plateau (about 5600 ft.) by R.A.F. Twenty-five specimens were brought back and all were this species. Further observations are needed to check this somewhat unexpected movement.

Hymenoptera : Ichneumonidae.

On 8th and 9th October small numbers of Ichneumonidae were moving south-west in the Gavarnie area along with the Diptera and other insects. The specimens captured were identified as :

Ichneumon sp.? :—4

Amblyteles equitatorius Panzer : 1 male, 3 females.

Ctenichneumon divisorius Grav. : 1 male.

Ctenichneumon editorius Linn. : 1 male.

Further observations are obviously needed before any definite conclusions can be drawn.

Summary and Discussion.

Our observations in the Pyrenees in the autumn of 1953 were in complete agreement with the previous records of Lack and others. Not only did we see extensive movements to the south through the passes in the Central Pyrenees

at Puymorens and Gavarnie, but we found similar movements along the Mediterranean coast just north of the Pyrenees.

While we were investigating the movement between Gavarnie and the Mediterranean, Burton and Owen (1954) were in the Landes and saw similar southward movements along the Atlantic seaboard, so there is little doubt that the southward migration is on the whole front from coast to coast.

By far the commonest migrants observed in the Lepidoptera were *Pieris rapae* and *Colias croceus*.

Next most abundant were *Pontia daplidice*, *Lampides boeticus*, *Vanessa atalanta*, *Argynnis lathonia* and *Macroglossa stellatarum*.

Pieris brassicae, *Aglais urticae*, *Papilio machaon* and *Vanessa cardui* were scarce but definitely moving.

Plusia gamma showed little evidence of daytime migration and only one *Colias hyale* was seen.

Unlike the occasion when the Lacks first observed the migrations in 1950, dragonflies were very scarce with little or no evidence of a southward trend.

The movements of Lepidoptera were all to the southerly quarter, but the direction of flight was undoubtedly influenced by the contours of the mountains. There was also an effect of sunshine which resulted in more activity on the west slopes of the valleys in the morning, and on the north slopes (i.e. facing south) most of the day. On one or two occasions there was evidence that different species were taking slightly different routes up the valleys or that they were flying in slightly different directions. For example *A. urticae* appeared to fly more definitely to the south in the Gavarnie area ; and *C. croceus* in the Puymorens area, between Hospitalet and the Col de Puymorens, flew rather higher up the valley side than *P. rapae*.

There appeared to be at times, especially at Gavarnie, a difference in the height above ground at which different species of Lepidoptera flew. Thus *P. rapae* and *V. atalanta* were often flying well above head height, up to 20 ft. or more, while *C. croceus* was rarely above 3–4 feet from the ground. The Diptera and Hymenoptera flew very low, almost always within a foot or two of the ground.

Although a strong wind might blow the insects out of their path, there was no evidence that the direction of flight was determined by the direction of the wind. The insects did not fly consistently with or against the wind but flew along the coast line or up the valleys in the same general direction whether the wind blew up, down or across their path. To study the local effects of wind we made use of a very simple, but possibly new, method of releasing dozens of small " soap bubbles " using a detergent solution and a small wire ring—the materials normally sold to amuse the children! The bubbles had a life of about half a minute and could be followed by the eye or field glasses ; it was thus possible to see the actual course of the wind simultaneously with the movements of the insects. This was particularly important in rough country and at cliff faces and other obstructions. The method seems capable of further development and application.

From our observations there is no doubt that sunshine is a major factor in determining the activity necessary for migration, and is much more important than actual air temperature. There were definite migrations on days when the temperature was as low as 50° F. if the sun was shining : and no movement at 68° F. if there was cloud or even thin haze. An exception to this rule was

M. stellatarum, which was seen migrating through Gavarnie village (4500 ft.) one day in thick mist and light rain.

As the amount of cloud is much greater over the hills than in the plains to the north, and greater in the high passes than in the foot hills, the range of the Pyrenees causes a hold up in the migratory movement. As the butterflies appear to have no difficulty in flying at the level of the Brèche de Roland (9000 ft.) on a fine day, and as we have records of migration of butterflies up to over 12000 ft. in the Himalayas (Westmacott and Williams, 1954), it would appear that the height of the mountains does not constitute a physical barrier to progress, but rather a meteorological one.

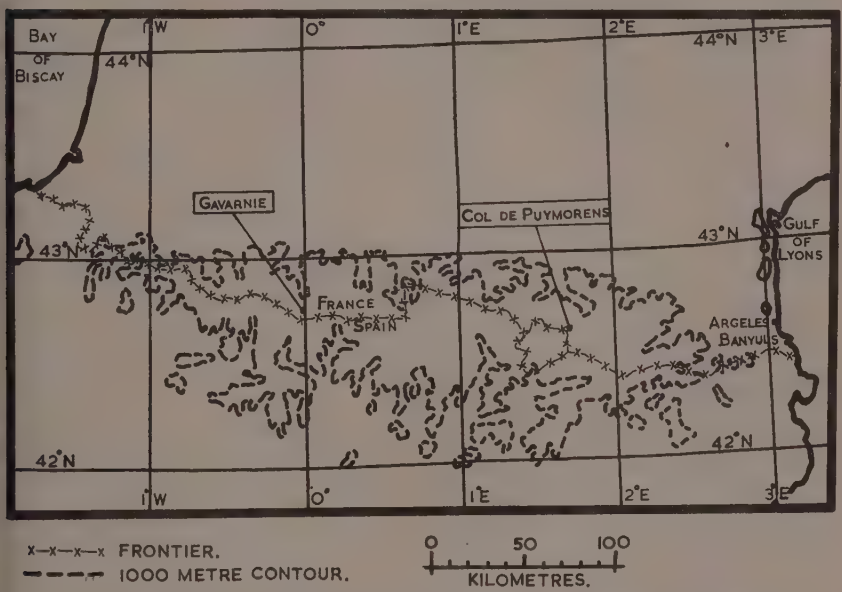

FIG. 4.—Map of the Pyrenees showing the localities where observations were made.

Most of the butterflies that we observed seemed to be flying at speeds in the neighbourhood of 5 to 10 miles per hour. The width of the mountain barrier varies considerably (see map, fig. 4) but is seldom greater than about 50–60 miles; and so, allowing for some following of the winding valleys, a continued flight of 8–10 hours might take an individual from one side to the other. Migrations were seldom observed before 9 a.m. G.M.T. (which is suntime at Gavarnie) or after 3 p.m., so that at the best two days flying might be necessary. The frequent cloudy weather at high levels might easily extend this to a week or more. Under conditions of sunshine on the plains to the north and cloud on the mountains there should be a build up of the population in the foot hills waiting for sunny weather to allow the crossing.

Turning next to the migrations of Diptera, this is undoubtedly one of the most interesting developments of our knowledge of insect migration. Lack

first established, and others besides ourselves have confirmed, the great numbers of Diptera that move steadily southward through the passes in September and October. The five principal migrants were :

SYRPHIDAE : *Eristalis tenax* and *Syrphus balteatus*

CALLIPHORIDAE : *Cryptolucilia caesarion*, *Calliphora erythrocephala* and *C. vomitoria*

The three latter are all scavengers feeding on dead flesh and decaying matter, but the two genera of Hover-flies differ completely in larval habits, *Eristalis* living in decaying material, either animal dung or wet vegetation, while the genus *Syrphus* includes only species which are predatory on aphids and other small insects. That two species of such diverse habits should be migrating together is in itself a new problem to solve.

The Diptera nearly all flew within a foot or two of the ground ; but, owing to the great difficulty of following them with the eye, it was not possible to get any exact measurement of their speed. The impression was of a fast flight, but the smaller the moving object the greater the impression of speed so that it is better to wait for more critical observations.

Since attention has been drawn to the regular migrations of Diptera in the Pyrenees, other older records of similar movement in the Alps and elsewhere have been discovered. For example, in September 1880 Eimer (1882) saw thousands of *Eristalis sylvaticus* Meigen and *Syrphus lavendulae* Macq., together with dragonflies, moving to the south-west up the Maloja valley in the Upper Engadine : and Prell (1926) in September 1924 saw a mixed flight of butterflies, dragonflies and Diptera (including *Eristalis tenax* and *Syrphus balteatus*) moving south over a pass north of Meiringen in Central Switzerland. These are both autumn movements to the south and with similar associations of insects. Still more recently Gansser (1951) has reported southward movements of *Eristalis* through the St. Gotthard Pass on 1st October, 1934, and other Syrphidae (including *Melithreptus dispar* Leew.) also going south through the Ueschinen valley in the Bernese Oberland in 1951 as early as 14th August. Perhaps still more interesting is that Westmacott, of the British Everest Expedition, saw a mixed migration of butterflies and Diptera flying through a pass at a height of 12000 ft. in Nepal in March 1953, in which the butterflies included *L. boeticus*, *P. brassicae* and an Indian species of *Colias*, and the Diptera included *S. balteatus* (Westmacott and Williams, 1954). Shannon (1926) has reported *Eristalis* and other Diptera moving regularly to the south in the autumn along the Long Island and New Jersey coasts in North America in a number of years.

The movement up the Pouey Aspé valley of the small beetle *Aphodius contaminatus* is curious and unexpected. At present we cannot be sure of the correct interpretation ; it might be a true migration crossing the Pyrenees into Spain, or it might be a movement up the hills to hibernating quarters, a habit that is known in some beetles (such as the Coccinellidae) but so far as we know has not been observed in any Scarabaeidae. It might also be a movement to lay eggs in the abundant dung of the horses, cattle and sheep that have been in the high pastures during the summer. Of the Hymenoptera seen moving with other insects in the Pouey Aspé valley, too few were captured to form the basis of discussion, but any future expedition should pay more attention to these unusual migrants.

Our observations in the Pyrenees have helped to establish the southward

autumn migration across the mountain barrier but they do not, of themselves, throw light on the origin or goal of the insects. Of the two most frequently observed species of migrant Lepidoptera, *P. rapae* is a resident species in Britain throughout the year, but we have evidence of both immigration and to a lesser extent emigration. *C. croceus* is a non-resident summer-breeding visitor, sometimes in great numbers reaching well into Scotland, sometimes very rare or absent. Of the less abundant migrants *P. daplidice*, *L. boeticus* and *A. lathonia* are all very scarce visitors to the south of England, seldom or never breeding. *V. atalanta* is a regular summer-breeding migrant, with evidence of a small winter survival in hibernation. *M. stellatarum* is a regular summer visitor which frequently breeds in southern England, but there is little or no evidence of winter survival.

P. brassicae and *A. urticae* are residents in Britain, but both are known to migrate. Our main immigration of *P. brassicae*, however, comes to England over the North Sea from the East and North-East about July. *V. cardui* is a regular summer-breeding visitor to Britain and *C. hyale* is in the same class but much rarer than *C. croceus*. The British *P. machaon britannicus* is considered to be a resident, but occasional wanderers of the Continental race *gorganus* have been found near the south coast.

So we see that most of the migrant species observed in the Pyrenees, with the exception of *P. machaon*, *L. boeticus*, *A. lathonia* and *P. daplidice*, might include individuals from as far north as Britain. On the other hand, in the years from 1950–1953 none of the species observed have been unusually abundant in Britain. In fact since the outstanding invasion of many species of Lepidoptera in 1945 and 1947, immigrations into the British Isles have been well below average. *V. atalanta* was, however, commoner in Britain in 1950 than in any of the following four years (though nothing like so abundant as in 1945 and 1947) and this may account for the fact that the Lacks recorded it as the second most abundant migrant. Records of *V. atalanta* in Britain in 1953 were less than one fifth of those in 1950. It thus appears likely that in a year when there has been a big immigration and a big increase of population in Britain and Northern Europe, the movement through the Pyrenees might be even more extensive than those already observed. There is little doubt, of course, that any southward movement will build up from the local population as it passes on, so that migration of all species will be more obvious in the south of France than in the north. In the plains to the north of the Pyrenees it will presumably be spread on a wide front, and then gradually concentrated into the higher valleys.

When we consider the goal of the migrants we are even more in the dark. Little is known of the winter homes of migrant Lepidoptera except that some are found in southern Europe, while others appear to cross over to North Africa or beyond. *V. cardui*, which was unexpectedly rare in Pyrenean movement in 1953, is known to cross the Mediterranean and has been seen flying southward about 80 miles off the coast of North-West Africa (Williams, 1946) under conditions that make it almost certain that they were on an over-sea flight of many hundreds of miles from South-West Spain to somewhere in the neighbourhood of Sierra Leone. Such long flights cannot be ruled out in other species, as Hocking (1953) has calculated that, owing to the high efficiency of a food reserve in the form of fat, many Lepidoptera are capable of flying several hundred miles without feeding.

Perhaps we could conclude with the following suggestions for future work.

(1) No-one has yet been able to show the date on which the southerly migration in the Pyrenees begins or ends. There is little doubt that observations should be started before the end of August, and that observers should be prepared to stay into early November. This means either long waiting in cold, wet windy weather at high levels for the occasional fine day on which movements may occur, or living lower down ready to get up to the passes when there is any promise of a few fine hours.

(2) For a study of the movement through the high passes it is most important that some, at least, of the observers should live in the immediate vicinity. For Gavarnie and Luchon this means camping equipment. At Puymorens there is a hotel at the top of the pass on the branch of the Ariège valley leading south to Bourg-Madame, but not on the branch leading toward the south-west into Andorra, where possibly the migration is more extensive. The Col de Puymorens has the further advantage that both sides are accessible by road and both are in French territory.

(3) We took with us a large black net with an opening about 4 feet high by 8 feet wide, with the intention of putting it in or near one of the passes, and leaving it out night and day to see what insects flew in. We were unable to test it, partly owing to continued bad weather and high wind, and partly because we found that it could not be left unattended, owing to the wandering cattle, horses and sheep. Mrs. Muspratt, who camped in the Pouey Aspé valley, found it necessary to protect her tent with a double line of posts with barbed wire, which adds considerably to the weight of equipment that has to be transported by mules or donkeys. We still think, however, that the use of a large stationary net would be very profitable, both for possible night migrants—such as *Plusia gamma*—and for the low-flying Diptera and other insects which move close to the ground during the day and are very difficult to catch in a small net. Further work on night migrants is urgently needed.

(4) Now that the autumn migration has been so definitely established by observation in four consecutive years, it becomes almost of more interest to study the spring movement in this area ; especially in the case of the Diptera, for which we have very little evidence for the northward flight. During the autumn migration, which is apparently at its height in September and October, there may be snow above 9000 ft., but usually the passes up to 7000 ft. or so are free and safe. At the time of the spring migration, which might be expected to start in April—or possibly even earlier—most of the upper portion of the hills are still under snow. Any movements over the high passes in such conditions would be most interesting to record, but much more difficult to observe than the autumn flights. There are, of course, records of insects found dead on the snow-fields in the Alps up to about 12,000 ft., but actual movements have only been seen on very few occasions. The routes that are taken by the spring migrants up the southern slopes of the Pyrenees in Spain will also be of great interest to investigate. Perhaps the spring movement is more definite in the lower country at each end of the mountain chain and less definite through the passes. There may be a difference between the routes in the two migrations.

(5) A comparison of the abundance of each species in the spring and autumn flights, and also of the relative abundance of different species, would be of

fundamental value. Some migrants build up their population in the south and lose ground in the north, so that the spring flights are larger than the autumn. In others (particularly in North America) the autumn flights are larger than the spring flights. In the Monarch Butterfly (*Danaus plexippus* Linn.) in North America, the autumn flight is gregarious and on narrow fronts, while in the spring flight to the north (made by the same individuals) the butterflies are more solitary and on a wider front. Does anything like this happen in our Western European migrants ?

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PLATES I and II.
The migration of insects in the Pyrenees.

a.—View of the Mediterranean coastline looking North from the hills just south of le Racou.

b.—View of the Ariège valley looking N. from the slopes above the Col de Puymorens.

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a.—Upper Pouey Aspé valley from the Port de Gavarnie, looking E.N.E. across the Gavarnie valley to the Hourquéte d'Allans.

b.—Upper Pouey Aspé valley with the Port de Gavarnie in the background, towards the left of the centre, and the Col de Tantes towards the right.